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CARE AND MAINTENANCE OF FARM ELECTRIC MOTORS

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According to a recent survey there are some 450,000 electric motors on California farms, or more than four per farm. The average size of these motors is 13.4 horsepower, but about two-thirds or 300,000 are ½ horsepower or less. The same survey revealed that approximately 10 per cent or 45,000 of the motors have required some type of repairs or replacement. Although natural wear was responsible for some of the repairs, probably half the damage could have been avoided by proper use, care, and protection.

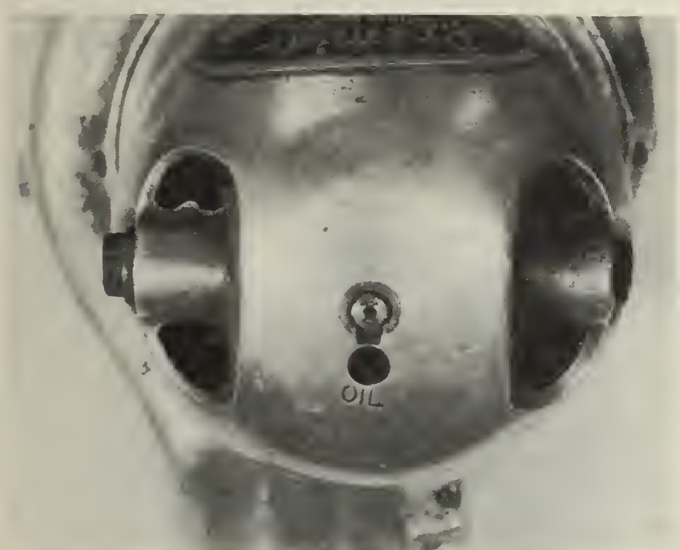

Fig. 1.--A bearing with little or no oil storage, which should be lubricated about once a month, or every 10 hours of operation. Two or three drops of oil at a time is sufficient.

Motors have a relatively simple mechanical construction, and little work or expense is required to keep them in good order. Frequent inspection and servicing are, however, necessary.

Reading the Name Plate

Each electric motor is equipped with a name plate that gives the name of the manufacturer and certain facts on the construction and operating characteristics. The user should be sure to read the name plate and know the meaning of the data. Many motors have been ruined by connecting them to the wrong type of electric current or to the wrong voltage, by overloading, and by improper fuse protection. A typical motor name plate reads as follows, and all the information thereon should be given when ordering parts or obtaining operating directions:

Blank Electric Company

A.C. Motor   Type KX

Frame 75			Model 8R192
H.P. ½	Ph. 1	Cyc. 60	R.P.M. 1725
Volts 110/220			Amps. 7.2/3.6
Temp. Rise 40°C			Serial No. M13618

The data on this name plate are explained below.

A.C. Motor: The initials "A.C." stand for alternating current. There are two kinds of electric current, direct (D.C.) and alternating (A.C.). Direct current always flows in one direction and is the type supplied by a battery and by small home generating plants. Alternating current flows in one direction one instant, then reverses and flows in the other direction; this is the type supplied by power companies. Although some motors will operate on either direct or alternating current, the majority are designed for only one type and should be connected to that type only.

Type KX: This is the manufacturer's designation for a particular kind of motor. Of the several different types of motors made, each has certain special characteristics. The principal difference among single-phase motors is in starting, some motors being designed to start under heavy loads, others under light ones. Before using a motor, advice should be obtained on its suitability for the job.

Frame 75, Model 8R192: These numbers are used by the manufacturer to indicate the dimensions and style of the motor.

H.P. ½: This designates the size as ½ horsepower and is the power that the motor is rated to develop when running under full load. Motors will develop more than their rated horsepower, but overloading heats them too much and injures them. Care should be taken not to connect a motor to a load that requires more power than the rating of the motor.

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Fig. 2.--A wool-packed bearing with small oil storage which should be lubricated with 8 to 10 drops of oil about every 3 months or every 200 hours of operation. The cylinder on the side of the bearing is packed with wool, which rubs on the shaft through a slot in the bearing.

Fig. 3.--A wool-packed bearing with medium oil storage, which should be lubricated with 25 or 30 drops of oil about every 6 months or every 500 hours of operation. The housing around the bearing is packed with wool, which rubs on the shaft through slots in the bearing.

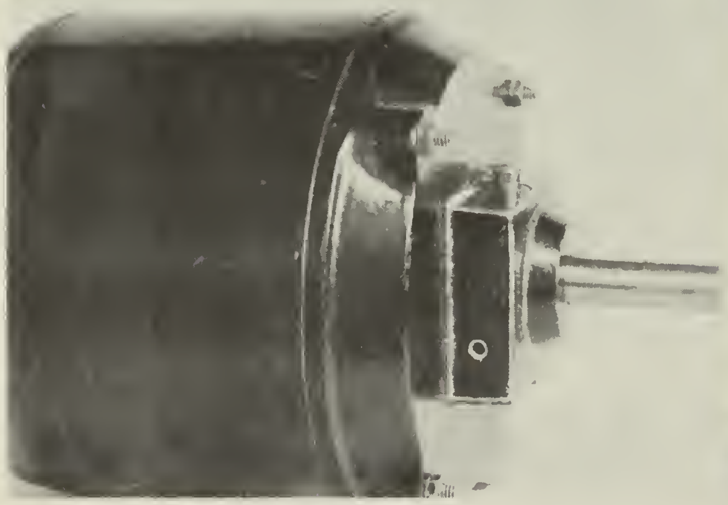

Fig. 4.--A wool-packed bearing with large oil storage, which should be lubricated once or twice a year. Enough oil should be added to fill the reservoir up to the overflow hole on the side.

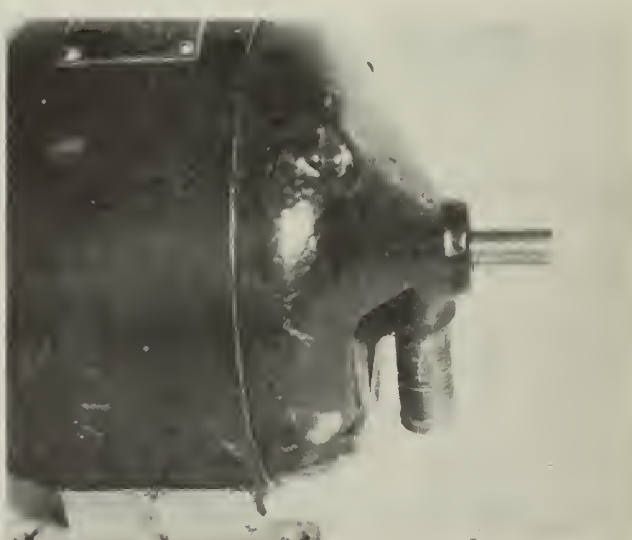

Fig. 5.--A wick oiler with medium oil storage. The removable oil well underneath contains a felt wick held by a spring, which extends up through a hole in the bearing and rubs on the shaft. The oil well should be kept about one half to two thirds full of oil. About once a year the old oil should be washed out and replaced with clean oil. The operator should inspect the wick occasionally to see that the end is soft and not glazed or hardened and that it is long enough to extend from the oil to the shaft. In replacing the oil well, care should be taken to fit the wick up through the hole to the shaft and not bend it back into the well.

Ph. 1: This signifies that the motor is single-phase. Two kinds of alternating-current motors are used on California farms--single-phase and three-phase. Single-phase motors require only two service wires and, although made in sizes up to 10 horsepower, are rarely used over 3 horsepower. They are most common in the sizes of 1 horsepower and less. Three-phase motors require three service wires (3-phase current) and are most common in sizes above 3 horsepower, although they are sometimes used in smaller sizes.

Cyc. 60: This denotes the number of cycles per second for which the motor is designed. A cycle is two reversals of the current; the current has traveled in one direction and has then reversed and gone in the other direction. In most of California the current is 60-cycle, although in some sections of southern California it is 50-cycle. Motors designed for 60 cycles will usually operate on 50 cycles and vice versa. But they will then be less efficient, will have a different speed, and (in the case of single-phase motors) may require some adjustments.

R.P.M. 1725: This designates the speed (revolutions per minute) that the rotor and shaft turn when operating at full load. Motors (60-cycle) with speeds of approximately 1740 are the most common, although motors with speeds of about 3475 and 1140 are also used to some extent. The corresponding speeds for 50-cycle motors are 1440, 2875, and 940.

Volts 110/220: This indicates the voltage for which the motor is designed. Motors having only one voltage on the name plate can be operated on that voltage only. Motors having two voltages indicated, like the one shown, can be operated on either. Dual-voltage motors, however, must be connected differently for the different voltages. Some motors have the method of connecting for the different voltages shown on the name plate, whereas others have it given in the directions for operation.

Amps. 7.2/3.6: This designates the electric current (in amperes) that flows through the service wires and coils of the motor during operation at full load. On single-voltage motors, one current value is given; on dual-voltage motors, two current values. The name plate shown indicates that when this motor is connected for 110 volts, 7.2 amperes will flow through it; and when it is connected for 220 volts, 3.6 amperes will flow through. The number of amperes necessary for operating the motor is important in determining the size of the service wires and the overload protective device.

Temp. Rise 40°C: This signifies that the temperature of the motor should not rise more than 40 degrees Centigrade (72 degrees Fahrenheit) above the surrounding air temperature if the motor is operated under the conditions for which it was designed. For example, if the motor operates in a room where the air temperature is 80°F, the temperature of the motor should not be over 152° in the hottest part.

Serial No. M13618: This is the manufacturer's number for a record of the motor.

Lubrication

To keep the bearings in good condition, regular and correct lubrication is essential. Poor lubrication results in worn bearings, which must be replaced. Since the method of lubricating the bearings varies with different motors, the instructions of the manufacturer should be followed whenever possible. Some bearings have little or no oil storage and require frequent lubrication; others, with larger oil storage, need lubrication only once or twice a year. Motors with ball bearings usually have the bearings packed in grease that lasts for several years, or, sometimes, for the life of the motor. The length of time the motor is used and the conditions under which it operates also affect the frequency of lubricating.

When no special oil is specified, automobile oil with a rating of S.A.E. 10 may be used for motors of less than ½ horsepower, and S.A.E. 20 for larger motors. Grease, if used, should be a good grade of ball-bearing grease or unmedicated vaseline. Care should be taken not to overoil the bearings, for oil leaking out not only collects dust and dirt, but also causes the insulation on the windings and wires to deteriorate and may cause the brushes or other parts to stick. It is best to oil the motor when it is not running, to avoid flooding of the bearings and leakage into the interior parts. Bearings packed with grease should not be filled more than about half full. Too much grease will cause excessive friction and pressure in the bearing, and the result will be overheating and breaking of the seal. A little oil or grease at regular intervals is better than a large amount at infrequent times. Figures 1 to 8 show various common types of bearing-lubrication systems, and the captions give general suggestions for their care.

Overload Protection

Proper protection against overloads is extremely important and may mean the saving of a motor that would otherwise be ruined. It has been badly neglected, however, particularly with small motors, because of difficulty in obtaining the right protective device and through lack of knowledge of its use and value. Electric motors will develop more power than their rating. Overloading that continues for some time, however, will overheat the motor and ruin the insulation, burn out the coils, or even start a fire. The length of time a motor can be overloaded without damage varies from an hour or so, with an overload of from 25 to 50 per cent, down to only a few minutes if the motor is stalled. It is particularly important to have overload protection on motors that are automatically controlled (for example, those in refrigerating units and domestic

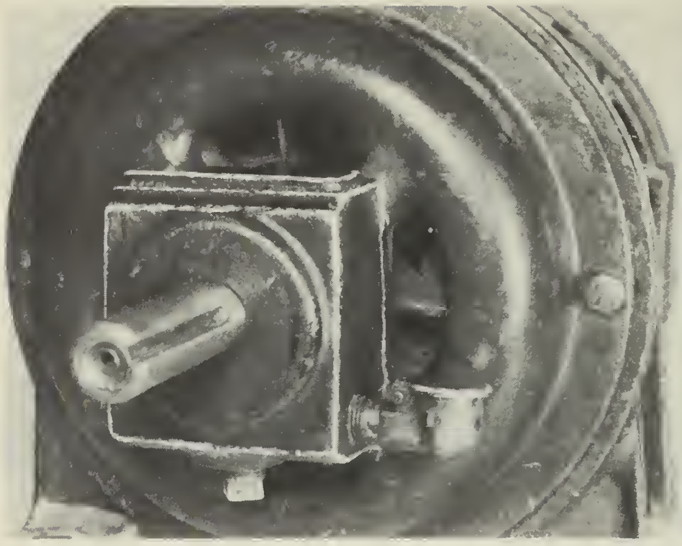

Fig. 6.--A ring oiler with large oil storage. A ring rests on the shaft through a slot in the bearing and extends down into the oil reservoir. When the shaft turns, the ring also turns and carries oil up on the shaft. The oil in the reservoir should be kept within about 1/8 inch of the top of the oil-filler cup located on the side. The bearing should be inspected occasionally to see that the ring is resting on the shaft and turns freely.

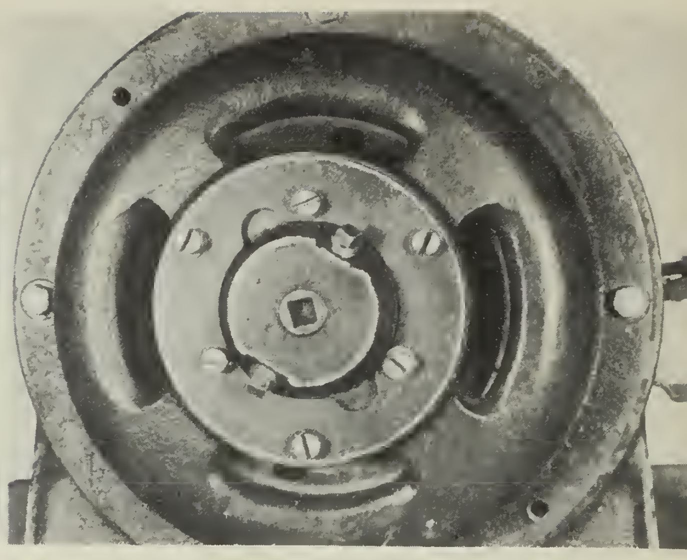

Fig. 7.--A sealed grease-packed ball bearing that should be inspected for grease about once a year. In greasing, both plugs are removed, and the grease is forced in through the top hole with a pressure gun until it comes out through the bottom hole. The motor should then be run for several minutes with the holes open to allow the excess grease to be forced out.

Fig. 8.--A sealed grease-packed ball bearing that requires only the addition of 8 or 10 drops of oil once each year to keep the grease soft.

water pumps) and on motors that operate without attendance. Even when someone is present, a motor may overheat and be ruined without being noticed. Overloads may be caused by connecting to too heavy a load, or by something going wrong either with the device being driven or with the motor itself.

The ordinary plug or cartridge fuses, such as those used for protecting the wiring system, are not suitable for overload protection on a motor. For proper protection, the protective device should have a current rating (in amperes) of not more than 10 to 20 per cent greater than the full-load current of the motor as indicated on the name plate. For example, a motor rated at 5 amperes should be protected by a device rated at not more than 6 amperes. When starting, a motor draws from 3 to 5 times as much current (amperes) as its full-load rating in order to develop the power necessary to bring it up to speed. Since the

ordinary fuse is designed to "burn out" immediately when overloaded, it will "blow" when the motor is started if the proper size for overload protection is used. If a size large enough to take care of the starting current is used, then the motor can develop 3 to 5 times its rated power or even stall without blowing the fuse. To take care of the starting current and still give proper protection, devices have been developed that have a time-lag or delayed-action feature. In other words, they do not open the circuit immediately when overloaded, but must be overloaded for a given time (depending on the amount of overload) before they operate. This feature permits the motor to get up to speed and the current to reduce down below the rating of the device. If a continuous overload is put on the motor, the device opens the circuit and cuts off the electricity before damage is caused. Figures 9 to 13 show various types of these protective devices, and the captions explain their use and operation. Some small motors can be obtained with a built-in overload protection at a cost of a few dollars extra.

When an overload protection is used, the following points should be remembered:

1. The device must be of the right amperage (not more than 20 per cent greater than the ampere rating of the motor).
2. Each motor should be protected by a separate device.
3. The device should be installed near the motor and should be only on the circuit serving that motor. It should not be installed in switches or fuse panels to which other equipment is connected.
4. If the device breaks the circuit to the motor, the operator should determine and correct the cause rather than increase the amperage of the protective device.

Cleaning

Except for certain special types, motors are ventilated to prevent them from overheating. A fan (fig. 14) mounted on the shaft inside the motor draws air in through openings in one end plate and blows it through the spaces around the coils and out through openings in the other end

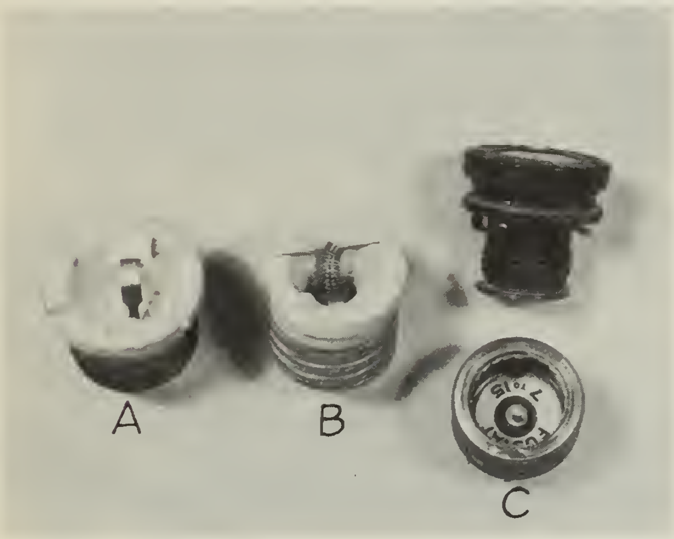

Fig. 9.--Types of fuses, showing differences in construction: A, Ordinary plug fuse, not suitable for motor protection. B, The Fusetron, a special fuse with a time-lag feature, suitable for motor protection. The spring is attached to the main link, and both are held by a fusible metal. When overloaded the metal melts and the spring is released, breaking the circuit. C, The Fusestat, a special fuse that is also suitable for motor protection. It is constructed and operated like the Fusetron, but is made in two parts. The base, which screws into the standard plug fuse receptacle, has a locking feature that prevents it from being taken out. The reason for the separate locking base is that fuses of different sizes require different bases, and only the size for which the base is designed can be used. This is to prevent replacing a fuse with a larger size. Fusetrons of the plug type and Fusestats are available in a number of sizes between 1 and 30 amperes. Fusetrons are also made in the cartridge form in sizes from 1 to 500 amperes. The Fusetron or the Fusestat must be replaced once it has opened the circuit.

Fig. 10.--A motor-starting switch with a built-in overload protection for small single-phase motors. The switch is manually operated and turns the motor on and off. An auxiliary mechanism, thermally operated, is used in conjunction for overload protection. If the overload device cuts off the current, it can be reset after being allowed to cool a few minutes, and does not require any replacement. The overload device is removable and can be obtained to fit any motor up to the maximum for which the switch is designed. These switches are made by several manufacturers and vary somewhat in size, shape, and type.

plate. Dirt, lint, and oil tend to collect in the air passages, restricting the flow of air and causing the motor to overheat even though it is not overloaded. An accumulation of dirt may also tend to work into the bearings or cause certain parts such as the starting mechanism and brushes to stick. A fair job of motor cleaning can sometimes be done by wiping and by blowing out the inside with compressed air from a bellows, bicycle pump, vacuum cleaner, or other source. To clean a dirty motor thoroughly or to clean one that is badly clogged, it is necessary to take the motor apart. The individual parts and the air passages can then be reached with dry clean rags, a paint brush, compressed air, or cleaning fluid. Care should be taken not to apply cleaning fluid to the coils or wiring unless this procedure is necessary to remove oil or grease, for it may damage the insulation. Stiff brushes or metallic equipment that may injure the parts or insulation should not be used.

Commutator and Brushes

The rotor (rotating part) on a farm motor is constructed in one of two ways. Figure 14,D, shows a so-called squirrel-cage rotor, which resembles a solid metal cylinder mounted on a shaft. Figure 15 shows a "wound" rotor, which has a number of coils of wire set in slots and connected to a series of copper bars on one end. The copper bars, which are insulated from each other by pieces of mica, are arranged in either a disk or a cylinder form called the commutator. The brushes are pieces of carbon (two or more), held in contact with the commutator by a holder and spring. Since the commutator turns and the brushes are stationary, there is friction between them, which causes wear on both. In some motors the brushes are in contact all the time, whereas in others they are thrown out of contact by a centrifugal device after the motor has reached a certain speed.

Brushes and commutators are subject to a number of troubles and must be kept in good condition. A poor contact between them may prevent the motor from operating properly or will cause excessive arcing (sparking) which increases wear on both the brushes and the commutator. Brushes should be inspected regularly for wear, freedom of movement in the holders, tension of the spring, and proper position. Badly worn brushes should be replaced with new ones because they may not be held correctly in the holders, the springs may rest on the holder instead of on the brushes, and (in extreme cases) the spring or the copper connection to the brushes may rub on the commutator. New brushes should be fitted to the commutator so that the entire end surfaces make contact. This can be done by placing a piece of sandpaper between the commutator and the brush, with the sanded side towards the brush. The sandpaper is then drawn in the same direction

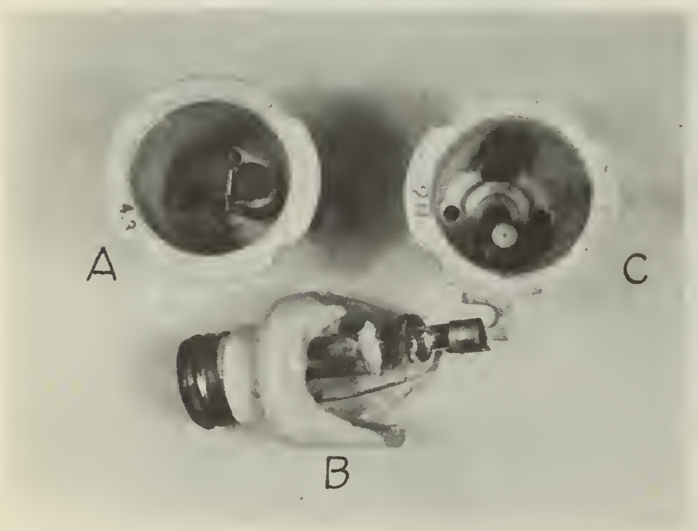

Fig. 11.--A thermally operated protective device. The two parts of the circuit are held together by a clip as shown in A and B. This clip is made in two parts, which are held together by a fusible metal. When too much current passes through the device, this metal melts and the clip comes apart, allowing the two parts to separate and break the circuit as shown in C. To reset, a new clip is installed. These devices are made in various sizes, with either a screw base or a clamp-on base. The screw base, however, has left-hand thread and requires a special receptacle.

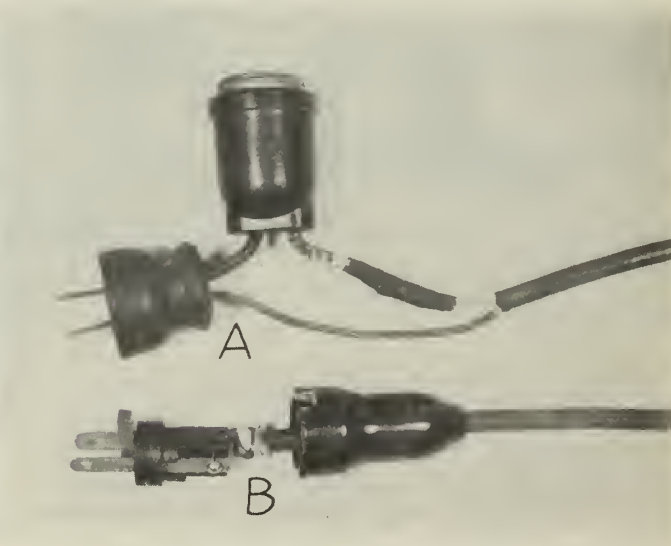

Fig. 12.--Devices for motor protection on cords: A, This homemade device is of a weatherproof socket (such as is used for outdoor lights) connected in series with one of the wires of the cord. A Fusetron or Fusestat screwed into the socket gives the protection. B, This ready-made device is an attachment plug with a thermally operated switch built into the handle. In case of overloading, the switch opens, and breaks the circuit. The switch stays open until reset by means of the lever located between the prongs. These plugs are available in ratings of 1 to 10 amperes.

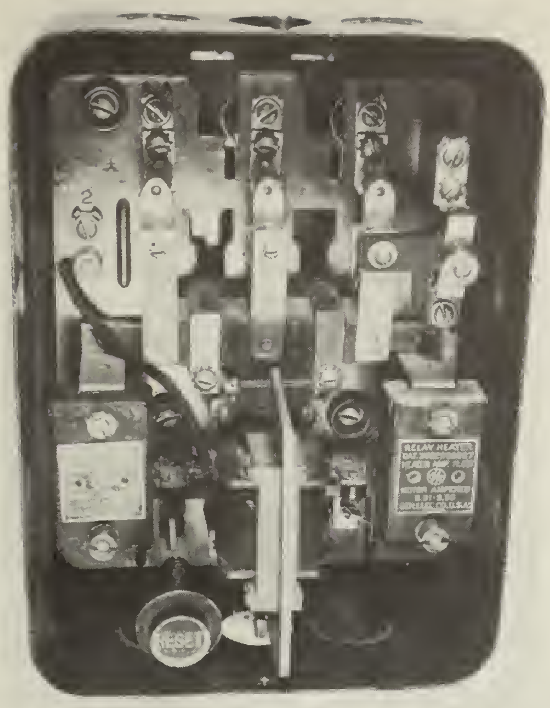

Fig. 13.--A magnetic switch with built-in overload protection. The overload devices are the two labeled parts on each side of the switch. The type of overload device varies with different switches; but all types can be suited to a particular motor size by changing a portion of the device or by making certain adjustments. When the overload protection has operated, it can be reset (after cooling) by pushing a button, pulling a string, or some other similar method.

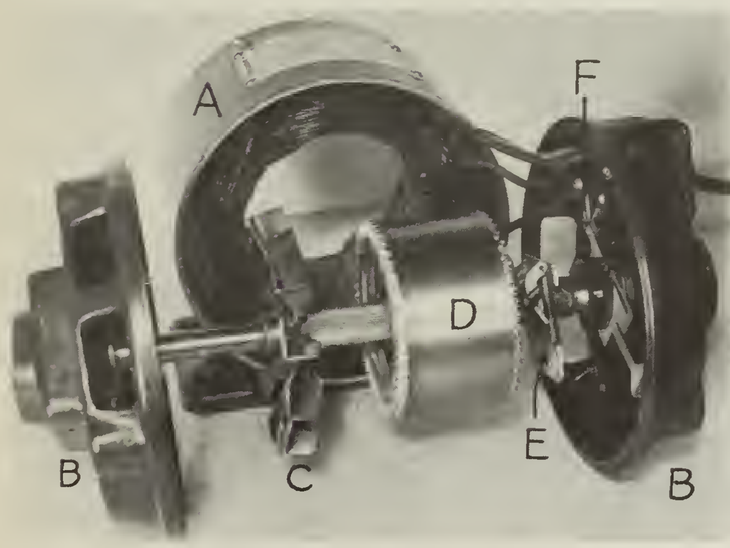

Fig. 14.--A motor with a squirrel-cage rotor disassembled to show the various parts: A, stator and coils; B, end bells, showing openings for ventilation; C, fan for circulating air over coils; D, squirrel-cage rotor; E, centrifugal device for opening switch on starting coils after motor gets up to speed; F, switch for cutting off current to starting coils.

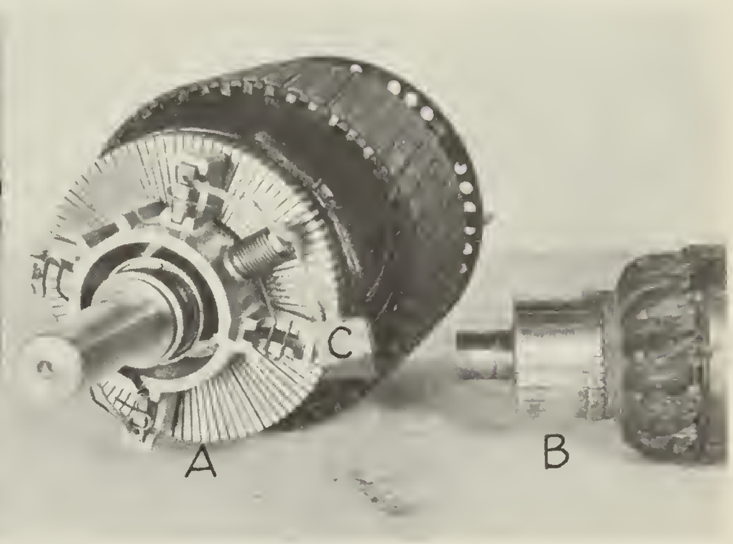

Fig. 15.--Wound rotors showing a disk-type commutator, A, and a cylinder-type commutator, B. One of the brushes, C, has been removed from its holder.

the commutator turns, care being taken to keep it curved the same as the commutator. Sticking of brushes in the holders can be prevented by keeping these parts free of carbon dust, dirt, oil, and other foreign material. The brush spring should be checked for breaks, corrosion which prevents free movement, and correct contact on the brush. On some motors the position of the brush holders is adjustable, and occasionally they may slip out of position. When brushes are removed, they should be marked and put back in the same holder and in the same position; otherwise they may not make proper contact with the commutator.

Commutators should be kept clean and smooth. They can be cleaned by wiping with a rag dampened with cleaning fluid. If not too badly worn or pitted, they can be smoothed with no. 00 or finer sandpaper. Emery cloth should never be used, for emery is a conductor of electricity and may lodge between the copper bars, causing a short circuit. If it is possible to reach the commutator when the motor is running, the sanding can be done by cutting the sandpaper into strips and holding it against the commutator with the end of a stick. Commutators that are badly pitted or grooved or on which the copper has worn lower than the mica (a condition known as "high mica") should be turned down and smoothed on a lathe. This job should be done by an experienced repairman.

Moisture

Moisture in a motor may cause a short circuit, damage the insulation, or cause corrosion of parts. A motor that has become wet inside should not be operated until dry. The best method of drying is to bake it in an oven at a temperature slightly above the boiling point of water (212°F). Another method is to blow warm, dry air through the motor. Motors should not be exposed to the weather. If used in places such as dairy barns or milk houses where water is apt to get on them, they should be of the splashproof type or should be covered by a housing. Ventilating holes should be left in each end of the housing for the circulation of air.

Belts and Alignment

Belts should be kept in good condition at all times. There is always danger that the belt may break or that pieces of it may come loose and become entangled in the motor or in the machine being driven; further damage may then result. The proper tension in a belt is important: tightness causes extra wear on the bearings; looseness allows slipping, which wastes power and damages the belt. No definite rule can be given for proper tension; it is affected by the type, size, and length of the belt. The tension must be judged by sag, vibration, whipping, squeaking, temperature of the bearings, and springiness.

Misalignment of belts (having the pulleys not in line) causes extra wear on the belt and bearings, vibration in the motor, and uneven tension and wear in the belt. Pulleys can be aligned by extending a straight edge or string from the outer edge of one to the outer edge of the other. Both edges of each pulley should just touch the straight edge or string.

Vibration

Vibration in a motor, as in other equipment, causes parts and connections to loosen, crystallizes metals, and results in extra wear. It may occur when the motor is loose on its base or is not on a solid foundation; when there are loose parts or worn bearings; when the rotating parts (such as the pulley) are out of balance; or when the belt is out of line.

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